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DESIGN AND DEVELOPMENT OF MICROSTRIP SENSOR WITH TRIPLE FREQUENCY FOR DETERMINATION OF RICE GRAINS MOISTURE CONTENT

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ABSTRACT

The micro strip moisture sensor is designed and developed with triple frequency, for determination of rice grain moisture content at 4.9GHz, 6.7GHz and 8GHz, with good return loss, as well as good bandwidth. The numerically and experimentally analyzed data using moisture sensor was for dry rice as well as wet rice. The proposed antenna is designed with substrate $\varepsilon_r = 4.3$, h =0.038mm, tan $\delta = 0.001$, as well as the parameters length and width are 10mm and radius is 2.1mm, simulated by CST software and measuring by the vector network analyzer (Model No. N9925A). The proposed design is useful for agricultural field, for determining the moisture content as well as low cost, small size, easy to fabricate, accuracy, less time consuming.

KEYWORDS: Micro Strip Moisture Sensor, Triple Frequency, Rice, Grains, Return Loss, CST Software & Vector Network Analyzer

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Original Article

INTRODUCTION

The micro strip sensor was first introduced for fish and meat processing, in 1970. After that, it was used for detecting the ripe fruits. This technique was increased gradually in the past years [1]. Micro strip patch antennas have been enhanced, with high bandwidth and the gain. In the other hand, Micro strip patch sensors have been also widely used in many fields, such as agricultures, industrials, food products, medicals, communication, etc [2-8]. It has been more useful, for detecting i.e., broken rice detection, impurities detection in water, soil moisture measurement, Rice Grain moisture, Rice quality detection, etc. Basically, the use of sensors is to change the physical & chemical properties [9-12]. A patch, which is a very thin metallic strip in micro strip antenna & the function, is to create a flat radiating structure on the ground plane [13-15].

Cereals and grains are very important part of the life without grains, nobody can survive in the world and important is how to protect the grains and seeds by the moisture, how to determine the quality, how to store the materials for a long time safely from the moisture content. This can be determined by the micro strip moisture sensor with a cheap, versatile and less time consuming [16-19]. Rapid determination of moisture content in the natural and manufactured products is important, for process and quality control [20-23].

The micro strip moisture sensor is very important, for measuring the moisture content in agricultural fields such as wheat, rice, soil, etc. Rice is most widely consumed staple food, for human beings, especially for

Asiatic population; it provides minerals, vitamins, etc. Rice can be grown easily, but important is that, how to protect the rice from the moisture because, we can't dry the rice in sunlight so, the micro strip moisture sensor is important for moisture content. Therefore, with the help of micro strip moisture sensor, it can be detecting the moisture in percentage in the storage place [24-26].

The proposed antenna is designed with substrate $\varepsilon_r = 4.3$, h =0.038mm and tan $\delta = 0.001$, as well as the parameters of length and width are 10mm and radius is 2.1mm as shown in figure 1, simulated by CST software and measuring by the vector network analyzer (Model No. N9925A).

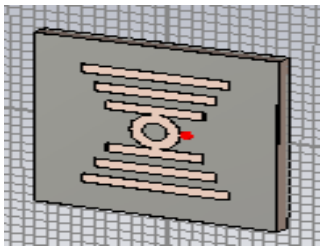

Figure 1: Structure of Micro Strip Moisture Sensor

ANTENNA DESIGN AND SIMULATION RESULTS

Proposed Micro Strip Moisture Sensor

The micro strip moisture sensor is designed with the parameters of length and width is 10mm and radius is 2.1mm, simulated by the CST software, after that fabricated as shown in figure 2 and measured by the vector network analyzer. The design is analyzed numerically and experimentally with dry and wet rice, as well as focused all the parameters which are related to moisture sensor, such as magnitude, phase, gain, return loss etc.

Figure 2: Fabricate of Micro Strip Moisture Sensor

Simulated Results

The design is analyzed by the CST software, as well as focused on all the parameters, which is related to the moisture sensor as shown in figure 3-6 given below-

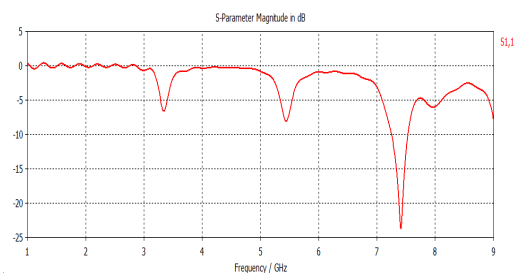

Figure 3: Return Loss of Micro Strip Moisture Sensor

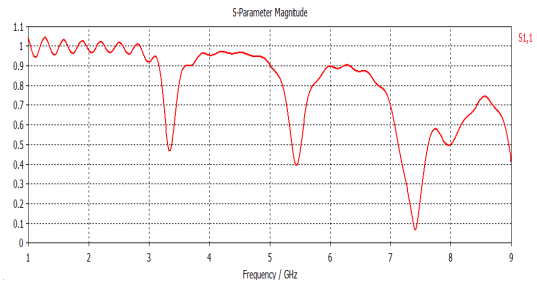

Figure 4: Magnitude of Micro Strip Moisture Sensor

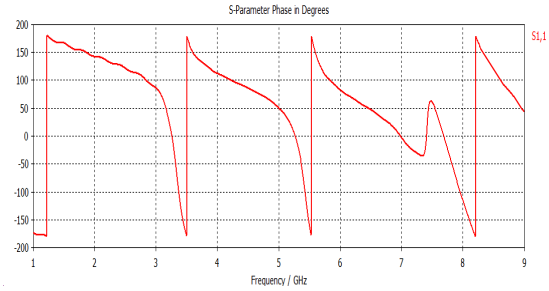

Figure 5: Phase of Micro Strip Moisture Sensor

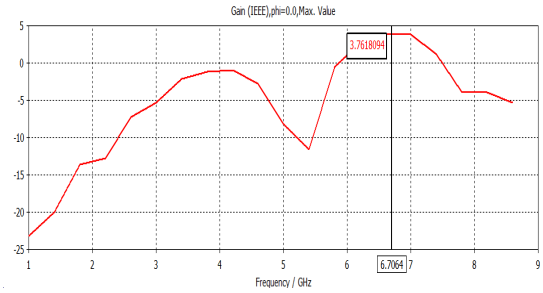

Figure 6: Gain of Micro Strip Moisture Sensor

Numerical and Experimental Results

The design is analyzed numerically with the dry rice grains and wet rice grains as shown in table 1 given below.

Table 1: Data of Dry and Wet Moisture Sensor

Frequency (GHz)	Dry of Return loss (S_{11}) dB	Wet of return loss (S_{11}) dB
1.4	-0.91	-0.91
2.03	-1.21	-1.28
2.7	-1.44	-1.44
3.02	-1.81	-1.39
3.29	-1.17	-1.39
4.1	-1.97	-2.45
4.6	-10.3	-10
4.8	-12	-11
4.9	-13	-10
5.7	-7.3	-7.7
6	-7.7	-6.5
6.7	-35	-15
7.4	-12	-10
7.6	-15	-17
8	-31	-18
9	-8	-6.7

The proposed design is measured of dry rice and wet rice with the help of vector network analyzer for detecting the rice grain moisture at different triple frequency. Firstly, proposed design is used for dry rice at different frequencies with the good return loss as shown above table 1 and measured results as shown figure 6-7, on the other hand measured for wet rice at different frequencies and calibrate then the return loss is less due to the moisture content in rice grains as shown figure 7-10.

Figure 7: Measurement of Moisture Content of Dry Rice Grains

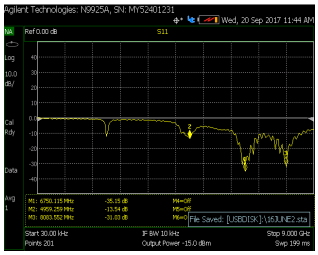

Figure 8: Performance of Micro strip Moisture sensor for Dry Rice Grains

Figure 9: Measurement of Moisture Content of Wet Rice Grains

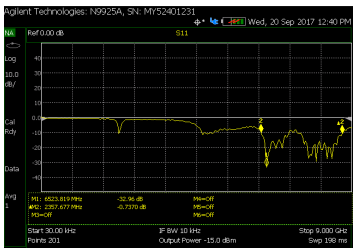

Figure 10: Performance of Micro strip Moisture Sensor for Wet Rice Grains

Vector Network Analyzer

The design is measured by vector network analyzer (Model No. Field fox N9925A) as shown in figure 11.

Figure 11: Vector Network Analyzer

CONCLUSIONS

The micro strip moisture sensor is designed and developed with triple frequency, for determination of rice grain moisture content at 4.9GHz, 6.7GHz, and 8GHz, with good return loss -13dB, -35dB, -31dB, as well as good bandwidth. The numerically and experimentally analyzed data was obtained, using the moisture sensor of dry rice as well as wet rice. The data of dry rice moisture sensor as shown in table 1, at frequency 4.9GHz, 6.7GHz and 8GHz with good return loss are -13dB, -35dB and -31dB, the data of wet moisture sensor as shown in table 1 at frequency 4.9GHz, 6.7GHz, 8GHz with return loss are -10dB, -15dB, -18dB. It is clear that, this numerical data and experimentally analyzed the moisture sensor is used for the determination of moisture content of rice grains, at triple frequency. The design is useful for

agricultural field, for determining the moisture content, as well as low cost, small size, easy to fabricate, accuracy and less time consuming.

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REFERENCES

1. *Thomas J.Jacson, Albin.J.Gasiewski, Anna Oldak, Marian Klein, Eni G. N joku, Aleksander Yevgrafov, Sven Christiani and Rajat Bindlish, " Soil moisture retrieval using the C-Band polarimetric scanning radiometer during the southern great plains 1999 experiments", IEEE Transactions on geosciences and remote sensing, vol. 40, no.10, pp 2151-2161, Oct 2002.*
2. *G.Biffi Gentili, G.Avitabile, C.Riminesi, N.Sottani, V.Tesi, "Microwave system for moisture mapping by a linear array of slot sensors", Sensors for industry conference houtan texas,USA, pp 32-34, 19-21 Nov. 2002.*
3. *Jackson B., Jayanthy T., "Moisture Content Determination Using Microstrip Fractal Resonator Sensor" Research Journal of Applied Sciences, Engineering and Technology, pp 2994-2997, 2014.*
4. *Neha Khanna, Gurmohan Singh, D.K.Jain, Manjit Kaur, " Design and Development of soil moisture sensor and response monitoring system", International journal of latest research in science and technology, vol. 3 issue 6 pp 142-145, Nov-Dec 2014.*
5. *Malathi C J, Thiripurasundari D. Review on isolation techniques in MIMO Antenna systems. Indian Journal of Science and Technology 2015 Sep; 9(35): 1–10.*
6. *Pandhare RA, Zade PL, Abegaonkar MP. Harmonic control by defected ground structure on microstrip antenna array.,Indian Journal of Science and Technology. 2015 Dec; 8(35): 1–5.*
7. *Thomas J.Jacson, Albin.J.Gasiewski, Anna Oldak, Marian Klein, Eni G. N joku, Aleksander Yevgrafov, Sven Christiani and Rajat Bindlish, " Soil moisture retrieval using the C-Band polarimetric scanning radiometer during the southern great plains 1999 experiments", IEEE Transactions on geosciences and remote sensing, vol. 40, no.10, pp 2151-2161, Oct 2002.*
8. *Lloyd BJ, Cnossen AG, Siebenmorgen TJ (2001) Evaluation of two methods for separating head rice from brokens for head rice yield determination. Appl Eng Agric 17(5): 643–648. Cheng E.M., Fraq M., Shahriman A.B.,Afendi R. M., Lee Y.S., KHOR S.F., Tan W.H., Fazli N., Abdullah A.Z., Jusoh M.A., (2014) "Development of microstrip patch antenna sensing system for salinity & sugar detection in water" IJMME 1431-1436.*
9. *Sweety Jain, Pankaj Kumar Mishra, Vandana Vikas Thakare " Analysis of moisture sensor based on microstrip patch antenna : A review", International conference on futuristic trends in engineering science, humanities and technology (FTESHT-16) volume 3, issue 1,January 2016.*
10. *Ghosh S., Roy A., Chakrabarty A., "Estimation of antenna factor of microstrip patch antenna as EMI sensor" progress in electromagnetic research letters 3, 113-122, and 2008.*
11. *Khalid K. and Abbas Z., "A microstrip sensor for determination of harvesting time for oil palm fruits", Journal of microwave power and electromagnetic energy", 27, pp 3-10, 1992.*

12. *Sweety Jain, Pankaj Kumar Mishra, Vandana Vikas Thakare "Design and Analysis of microstrip moisture sensor for the determination of moisture content in soil", Indian journal of science and technology, vol.9, issue 43, Nov. 2016.*

13. *Singh D.K., Kumar P., Rizvi N.Z., "Microstrip transmission line sensor for rice quality detection" IJERGS, 2, pp 589-598, 2014.*

14. *Sweety Jain, Pankaj Kumar Mishra, Vandana Vikas Thakare "A Rectangular microstrip moisture sensor based on microwave measurement technique", SKIT Research Journal, vol.7, issue 1, 2017.*

15. *Sweety Jain, Pankaj Kumar Mishra, Vandana Vikas Thakare "Bandwidth and Gain enhancement in microstrip moisture sensor for agricultural applications", Indian journal of science and engineering research" vol.1, issue 1, July-Dec, 2017.*

16. *Sarabandi K., Senior member, IEEE, Li E.S., "Microstrip ring resonator for soil moisture measurements" IEEE Transaction on geoscience & remote sensing, 35, pp 1223-1231, 1997.*

17. *Sim Z.W., "Investigation of PCB Microstrip Patch Receiving Antenna for Outdoor RF Energy Harvesting in Wireless Sensor Networks" Loughborough Antennas & Propagation Conference, pp 129-132, 2009.*

18. *Guo C., Li T., Zhang Y., "Numerical & Experimental study of a Microstrip Resonator Moisture Sensor" AISS, 4, pp 591-600, 2012.*

19. *Yahaya N.Z., Abbas Z., Ismail M.A., Ali B.M., "Determination of moisture content of hevea rubber latex using a microstrip patch antenna", PIERS proceedings kuala lumpur, malasiya, pp 27-30, 2012.*

20. *M. P. Abegaonkar, R. N. Karekar, and R. C. Aiyer, "A Microwave Microstrip Ring Resonator as a Moisture Sensor for Biomaterials: Application to Wheat Grains", Measurement Science and Technology, vol. 10, no.3, pp 195-200, 1999.*

21. *Kirandeep Kaur, Rita Mahajan, Deepak Bagai, "A Review of Various Soil Moisture Measurement Techniques" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization), Vol. 5, Issue 4, pp 5774-5778, April 2016.*

22. *Elwi T.A., Khudhayer W.J., "A passive wireless gas sensor based on microstrip antenna with copper nanorods", progress in electromagnetic research B, 55, pp 347-364, 2013.*

23. *Zhang Y., Okamura S., "A Density –Independent Method for high moisture content measurement using a microstrip transmission line", journal of microwave power & electromagnetic energy, 2006.*

24. *Bogosanovich M., "Imaging and sensing team, "Microstrip patch antenna sensor for measurement of the permittivity of homogeneous dielectric materials", IEEE, pp 31-36, 1999.*

25. *Toba T. and Kitagawa A., "Wireless moisture sensor using a microstrip antenna", Journal of sciences, pp 1-6, 2011.*

26. *Kit H., Yeow K., Dimon M.N., "Rice grain moisture determination using microstrip wide ring & microstrip coupled line sensors" AJAP, pp 112-120, 2015.*